
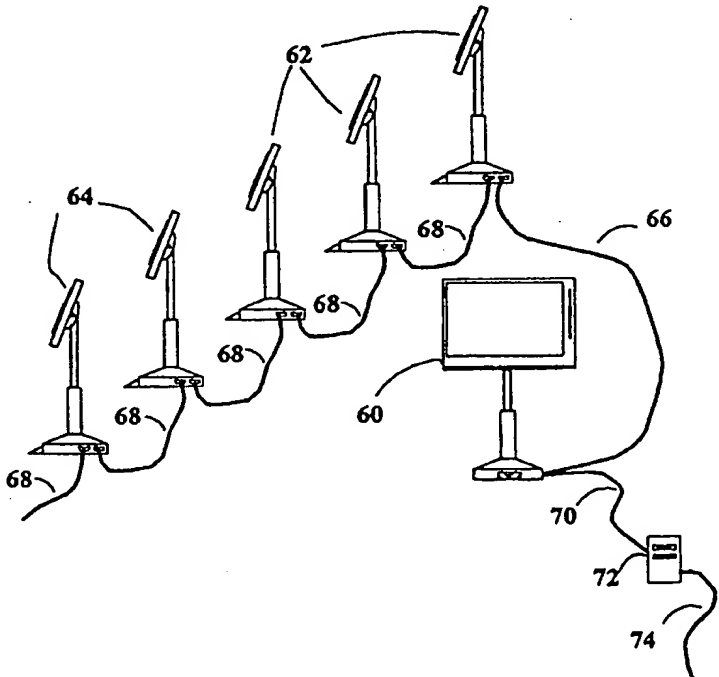




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p><b>(21) International Application Number:</b> PCT/US98/08658</p> <p><b>(22) International Filing Date:</b> 30 April 1998 (30.04.98)</p> <p><b>(30) Priority Data:</b>          08/851,082      5 May 1997 (05.05.97)      US</p> <p><b>(71) Applicant (for TJ only):</b> FRIEDMAN, Mark, M. [US/IL];          Alharizi 1, 43406 Raanana (IL).</p> <p><b>(71)(72) Applicants and Inventors:</b> ARONSON, Danny [IL/IL];          Barth 5, 69104 Tel Aviv (IL). RESNICK, Alon [IL/IL];          Mordechai 15, 47441 Ramat Hasharon (IL).</p> <p><b>(74) Common Representative:</b> FRIEDMAN, Mark, M.; c/o Casto-          rina, Anthony, Suite 207, 2001 Jefferson Davis Highway,          Arlington, VA 22202 (US).</p>		<p><b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b>  <i>With international search report.</i></p> <div style="text-align: right;">  </div>
<p><b>(54) Title:</b> MUSICAL SCORE DISPLAY AND EDITING APPARATUS AND SYSTEM</p>		
<p><b>(57) Abstract</b></p> <p>Device (6) displays musical scores to performing musicians incorporating data processing capabilities and via a system may be interconnected for the simultaneous display of scores over a network, allowing coordination of music performed by an ensemble. The leader's device (60) functions as a master device distributing display information to other devices (62, 64). All devices (60, 62, 64) are interactive, allowing editing of the music by the leader during rehearsal or prior to performance. The ensemble leader may insert instructions into the musical score modifying the score and its arrangement using various music editing commands which will be displayed on all devices displaying parts of the score to which they apply; individual musicians may also insert personal annotations into their own parts of the score, but these will be displayed only on their own individual devices.</p> <div style="text-align: right;">  </div>		



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## MUSICAL SCORE DISPLAY AND EDITING APPARATUS AND SYSTEM

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a system of data processing apparatus for  
5 displaying musical scores to musicians and, more particularly, to apparatus and a  
system which displays musical scores simultaneously over a network, which thereby  
provides musical information to performing musicians playing in an ensemble, and  
which allows the leader of the ensemble to make changes and annotations to the  
scores while the music is being rehearsed and performed.

10 Hereinafter the term "musician" denotes any person who performs music,  
either by playing a musical instrument or by other means, such as by singing or by  
conducting an orchestra. Hereinafter the term "ensemble" refers to any group of at  
least two musicians performing together, such as a band, an orchestra, or a choir.  
Hereinafter the "leader" of the ensemble refers to any musician who directs or guides  
15 the performance, such as a composer, conductor, or lead musician. Hereinafter the  
term "individual part" refers to the written musical notation for a performance of a  
piece of music by a specific instrument, voice, instrumental group, or voice group.  
Hereinafter the term "score" refers to the written musical notation for a piece of music  
in general, including individual parts for the various musicians as well as the parts for  
20 the complete piece taken as a whole. The individual parts of a complete score may be  
for simultaneous performance and they may overlap in time. Hereinafter the term  
"music data" refers to any information which pertains to the performance or  
production of music, including, but not limited to: pitch, musical scale, key, tone,  
tonality, and intonation; instrumentation; melody; harmony; rhythm, tempo, meter,

and timing; dynamics; expression; and articulation. Hereinafter the term "annotation" refers to any incidental information included on or with a musical score to assist a musician in the performance of music.

Currently, data processing systems are widely used to compose and arrange musical scores. Data processing technology offers many advantages, such as ease and accuracy in composing music and making changes guided by real-time interaction with simulated music while composing and arranging, and permits composers and arrangers to be more productive with their time. Such music data processing systems typically consist of computers running special music application software, and usually interfaced to special music apparatus. Such special music apparatus includes input devices which simulate the feel and behavior of musical instruments, such as music keyboards and drum pads, as well as output devices which electronically create musical sounds, including sounds which simulate those of traditional musical instruments. A music data processing system equipped with such features allows composers and arrangers to improvise and play music directly into the system; to store, retrieve, and transmit the music in standardized computer data formats; to manipulate and change scores, arrangements, and instrumentation using the music application software; to play back the music through audio equipment and record it on standard audio media; and to print the music on paper in standard musical notation for distribution to performing musicians. The advent of such data processing capabilities in the composing and arranging of music has had a profound impact on the musical art form by facilitating the creativity of composers and arrangers and relieving them of the burdens of managing information.

Unfortunately, performing musicians and ensemble leaders do not benefit from such advanced systems and their improved methods, results, and productivity, and currently must still rely solely on the use of traditional printed scores on paper. There are many disadvantages of printed paper scores:

5           First, there is no interaction between the musician and the printed score during rehearsal or performance. Annotations must be done verbally by the leader, without the benefit of musical notation. Such verbal annotations must be written down individually by each musician. The resulting written annotations are prone to communication gaps and their intended meanings are easily forgotten or confused.

10           Second, because composers gain such extensive benefit from music data processing, many are finding it increasingly difficult to work efficiently with live musicians, who are still restricted to the use of printed paper scores. Because of the limitations of printed paper scores, the live musician is being phased out of the creative process, and this loss is detrimental to the quality of the musical arts.

15           Third, changes necessary to the scores during rehearsal or prior to performance must be made manually on the printed pages. Making other than trivial changes during rehearsal or prior to performance is prohibitively difficult and requires reprinting the entire score. In addition, errors are difficult to correct and likewise require reprinting the entire score.

20           Fourth, the simple task of turning a page of a printed score while performing imposes severe restrictions on the layout of the scores. The page breaks must be adjusted so that they do not occur during a demanding passage, and making this adjustment often entails tedious and laborious work. In addition, during rehearsals the leader often directs the musicians to turn to a specific bar or passage of the music.

Because the individual parts are paginated differently, there is no convenient way to make universal reference to the page location of the required bar or passage. Thus, the cumulative time required for the various musicians to locate the appropriate places in the score can become extensive.

5       Fifth, managing a large quantity of printed scores, including their storage, retrieval, organization, distribution, and maintenance imposes a burden on the musicians and ensemble leaders, and detracts from their ability to devote their energies to the music itself. Moreover, printing music (scores, sheet music, etc.) is not only becoming increasingly expensive, but it is also highly wasteful of paper.

10       Sixth, scores which are available only in printed form are often not readily available to musicians. Comprehensive music libraries are few and are not conveniently located for the benefit of most musicians. Moreover, new music is rarely found in printed form in music libraries.

In contrast to this, information which is distributed, managed, edited,  
15 maintained, and viewed electronically suffers from none of these drawbacks. Huge quantities of electronically-represented information can be stored compactly and inexpensively, and may be accessed quickly and easily on a global scale via information networks such as the Internet. Such information may be retrieved, edited, and transformed rapidly by low-cost data processing equipment, and displayed  
20 interactively without the costs, waste, and burdens associated with printing on paper.

There is thus a widely recognized need for, and it would be highly advantageous to have, apparatus and a system that can organize and display musical scores to musicians and ensemble leaders interactively in real time, which would eliminate their current dependence on printed paper scores and bring them the benefits

of music data processing. Not only would it facilitate the performance of music, but such a system would close the gap in artistic freedom which currently exists between the performing musician and the composer/arranger. It would re-incorporate live performing musicians into the mainstream of the creative process and thereby enable  
5 them to artistically participate in the creation of the music as well as its performance.

### SUMMARY OF THE INVENTION

According to the present invention there is provided apparatus for displaying and annotating a musical score, comprising: (a) a display screen; (b) a display controller for the controlling the display of the musical score on the display screen; (c)  
10 an input device for annotating the musical score on the display screen; and (d) at least one foot-operated controller for selecting a portion of the musical score to be displayed on the display screen.

The display screen can be implemented in various ways, for example by a cathode ray tube, or preferably by a backlit flat screen liquid crystal display such as  
15 used in notebook computers. The display controller can also be implemented in various ways, for example: by a data processor with a stored program, such as a program stored in read/write memory ("software") or a program stored in read-only memory ("firmware"); or by a circuit of interconnected logic elements dedicated to the display and annotation of a musical score, such as a circuit of discrete logic  
20 devices (such as gates, flip-flops, shift registers, and so forth), programmable array logic (PAL), application-specific integrated circuitry (ASIC), or other custom integrated circuitry.

Such apparatus serves to display musical scores and information to a performing musician, such as a musician performing in an ensemble.

According to further features in preferred embodiments of the invention described below, the apparatus can be provided with a pointing input device, such as a pen pointing device, for making rapid annotations, such as with musical symbols selected from a menu.

5       According to still further features in the described preferred embodiments, the apparatus can be provided with a data transfer device for exchanging data with other apparatus of the same type, or with different apparatus, such as general-purpose computers or servers on a data network. Such a data transfer device can be implemented in a variety of ways. For example, a removable-media data storage  
10   device can serve as a means of exchanging data written on the removable media, which can be physically transferred between the apparatus and other units. Such an arrangement has the advantage that the data transfer can be delayed in time and can be repeated as often as necessary, but it cannot handle bidirectional data transfers in real time. For real-time bidirectional data transfers ("communication"), data input/output  
15   devices ("data ports") may be used, and the data may be passed between communicating apparatus by means of data cables or by other means such as infrared or radio-frequency data transceivers. A special type of data input/output device is able to access a data network. Examples of such devices are Ethernet devices, or a modem for dial-up connection to an Internet server.

20       According to still further features in the described preferred embodiments, a version of the apparatus functions as a master, or lead apparatus, for use by a leader of an ensemble of performing musicians. This embodiment of the apparatus includes a data processor and software for the editing of musical scores; storage devices for



removable media, such as a floppy disk drive and CD-ROM drive, and a detachable data input keyboard.

According to another embodiment, it is possible to configure a system of such apparatus for use by an ensemble of performing musicians by providing the apparatus with data transfer devices, for example with at least one, and preferably a plurality of input/output data ports interconnected between different units of apparatus by data cables or by other means such as infrared data transceivers. The individual units of apparatus can be connected to one another in various ways; for example, if data cables are used the units could be connected in a linear "daisy chain" fashion, where each unit can be connected to one or two others so that they follow sequentially in a continuous line, with the leader's unit at the head end. If, on the other hand, infrared transceivers were used, the leader's unit could broadcast to the other units simultaneously, and they could respond on individually coded channels. Regardless of the specific configuration, the lead apparatus serves as a master to distribute the score and the leader's annotations to the units of the ensemble via the interconnections as the music is being rehearsed or performed. The various units used by the musicians can be differentiated by software to capture and display only those individual parts which are appropriate for them, and ignoring those individual parts which are not appropriate. More than a single musician may utilize the same unit, in a manner similar to the traditional practice of sharing printed paper scores among several musicians.

The leader's unit can also be connected to an external server or network, in order to download musical information from a library of musical scores in any of several standard music data formats.

In addition to being interconnected with other units of such apparatus, the leader's unit may also be used as a stand-alone workstation to prepare for rehearsals or performances. Using it, an ensemble leader can download scores from an external server or a library of musical scores on a network; or may load them from removable media storage, such as floppy disk or CD-ROM. The ensemble leader can edit the arrangements of the scores to suit a particular instrumentation or program of music, and prepare a performance in advance. Then the leader may connect the unit to the units of an ensemble for rehearsal via the interconnections. The scores of the performance stored in the leader's unit can then be sent to the units of the performing musicians as the rehearsal or performance takes place.

While performing the music, a musician can control the scrolling of the display of the score on the apparatus by means of at least one, and preferably a plurality of foot-operated switches or controllers, thus solving the current problem of page-turning altogether and eliminating the need to detract attention from the performance in order to turn a page.

At any time, such as during rehearsal, the leader can modify the musical scores. Examples of changes could include rearranging sections, transposing pieces, adding or changing notes, tempo, meter, rhythmic patterns, and changing the instrumentation by exchanging parts between instruments. The leader may also annotate the music. Examples of annotation include dynamics, such as *piano* (soft) or *forte* (loud); articulation, such as *staccato* (abrupt) or *legato* (smooth); and tempo, such as *allegro* (lively) or *andante* (slowly). There are notational symbols which may be applied to individual notes, groups of notes, and passages, as well as to entire sections of music to indicate a wide variety of artistic expressions. All of these may

be quickly inserted into the score by the leader upon selection from predefined menus, in a manner similar to that utilized by current music processing software, such as *Finale*, published by Coda.

Changes made in this way will be stored in the memory of the apparatus for further editing, if desired. The leader may also add annotations to the music during rehearsal or performance to convey additional musical information to the musicians. These annotations will be displayed in the appropriate places of the musicians' scores on their units. Using a pen device, individual musicians may also place annotations in the scores for their own benefit, and their annotations will be stored in the leader's unit so that they can refer to them in the future. These annotations, however, will be displayed only on their individual units and not on the apparatus used by the other musicians of the ensemble. Such annotations could include inserting textual annotations (for example, "look at oboist at bar 30"), as well as standard musical symbols (notes, slurs, dynamic marks, and so forth) selected from a menu. These annotations could also be edited. Even though an individual musician's annotations would not be displayed on the apparatus of other musicians, it would be possible to view another musician's part (for example, "oboe part at bar 30").

Other timing information can also be supplied to the apparatus in data format for the precise coordination of the performed music with external events, for example the recording of a motion picture score with the Society of Motion Picture Technicians and Engineers (SMPTE) time code.

The present invention discloses a system which can be put to good advantage in a wide variety of situations where an ensemble of musicians performs. Not only is this system applicable to the performance of live music of all kinds, but it represents a

novel advance over the current practice of using printed scores on paper for production music, such as music for theater, cinema, video, and recordings. Its ability to accept and display music in standard data formats eliminates the need to transcribe music onto paper and make written changes on paper, and thereby increases the efficiency of the music production process from composer to arranger to rehearsal and performance. The present invention is the key innovation to achieving a significant reduction in the use of paper throughout the entire music industry.

The present invention discloses an innovative arrangement of hardware and software configured specifically for performing musicians and ensemble leaders. It successfully addresses the shortcomings of the current practice of furnishing only printed scores on paper to performing musicians and their leaders by providing data processing apparatus and a system for the display and editing of musical scores during rehearsals and performances, thereby bringing them the benefits of music data processing. By relieving them of the burdens of tedious data handling, the present invention allows musicians to better apply their energies to the creative interpretation of music.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is hereinafter described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 shows a prior art printed paper score;

FIG. 2 shows apparatus according to the present invention for displaying musical scores to musicians;

FIG. 3 shows apparatus according to the present invention for displaying and setting up musical scores for use by ensemble leaders; and

FIG. 4 shows a plurality of apparatus as in FIG. 2 and FIG. 3 interconnected into a system for display of musical scores to an ensemble of musicians under the direction of a leader.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

5           The present invention is of data processing apparatus and a system which displays musical scores and which allows the leader of an ensemble of performing musicians to edit and annotate the scores. The principles and operation of apparatus and a system according to the present invention may be better understood with reference to the drawings and the accompanying description.

10           Referring now to the drawings, FIG. 1 illustrates a prior art printed paper score. Persons knowledgeable in the art will appreciate some of the many limitations inherent in the use of printed paper scores with reference to this example. FIG. 1 shows the full score for a portion of an octet by the composer Igor Stravinsky. This full score is what the leader would read to conduct the ensemble performing this  
15           piece. The score is read in portions separated by short double lines 50; that is, the portion 52 is followed by the portion 54, which is followed by the portion 56. The instrumentation for this piece is indicated by notation 58 and includes one flute, one B-flat clarinet, two fagotts (bassoons), two trumpets, and two trombones. Each of these instruments has a different individual part formatted on an appropriate staff 60.  
20           Thus, it is necessary to extract eight additional, different sets of printed material in order to perform this piece of music. Persons knowledgeable in the art will appreciate that this is a relatively simple example of the difficulties encountered in using printed paper scores. The octet has but eight individual parts, whereas more elaborate pieces of music, such as Mozart's 40th Symphony, have between 30 and 40 individual parts.

Some of the musical annotation in this score includes the insertion of breath marks 64 and passage numbers 66. The individual parts often have considerably more detail in their annotations, but the leader does not have access to them. Moreover, there is often a need for the musicians to interact among themselves, and there is no way for the leader to make annotations in the individual parts to this effect. Note also that passage numbers 66 do not correspond to a fixed number of bars, but vary from five to seven bars in length for this particular score. These are used by the leader for reference when rehearsing the piece, and it will be appreciated that a particular passage number may occur on a different page number for each of the individual parts, making it difficult for the musicians to rapidly turn to a requested passage.

In addition to the burdens of extracting, printing, and managing the paper scores, there are also limitations to the musical information that printed paper can convey to musicians. Music is a dynamic art, whereas printed paper is completely static, and this limitation is illustrated by the challenge of helping musicians keep time during a demanding passage, described as follows. Passage 52 has all eight staves or instrumental parts, since each instrument plays during at least part of this passage. Passage 54, however, has only five staves, since the flute and the trombones are silent during this passage, and passage 56 has only seven staves, since only one of the trombones plays during this passage. The individual parts for the instruments which are silent, however, must include all the bars of the music even during the silent portions. Rather than show long passages of rests, however, the printed paper individual parts compress long periods of silence with a compact notation which merely indicates how many bars are silent for that part. But this often makes it difficult for a musician to know exactly how long to remain silent and exactly when to

resume playing. In this piece of music, there are two changes of time signature 68 in passage 54, and it is often difficult to accurately count bars when the rhythm changes abruptly and rapidly as it does here. The musician will rely on the leader to signal when it is time to resume playing after a period of silence, but interactive apparatus, such as that of the present invention, can display accurate timing information superimposed on the display of the score, and thereby provide much higher quality musical information than printed paper scores.

FIG. 2 illustrates two views of one possible embodiment of apparatus according to the present invention for the display of musical scores and information to a performing musician. FIG 2a is a frontal view, while FIG. 2b is a side view. Such apparatus includes a console 10 to interface with the musician, including a display screen 12. A pointing device 14 can be used to input information into the apparatus, by selecting from visual icons on display screen 12, or by writing onto display screen 12. Console 10 is supported by an extension 20 and has a pivot 18 to allow the musician to adjust it to a convenient angle. Extension 20 telescopes from a base column 22 to allow the musician to adjust console 10 to a convenient height. A base 24 supports the apparatus on the floor, stage, or platform where the musician is performing, and has foot-operated switches 28 to allow the musician to input simple commands to the apparatus while performing, such as a command to scroll down the display of the musical score. The apparatus is also provided with data input/output ports 26 to allow it to be interconnected in a system with other devices. Data processing circuitry (CPU, memory, device controllers, I/O, and so forth) can be located wherever feasible, such as in base 28 or in console 10.

FIG. 3 illustrates another possible embodiment of apparatus according to the present invention, for the display of musical scores and information to an ensemble leader. Such apparatus has a display screen 40 of increased size to display larger amounts of musical information. The apparatus also has a compact computer cabinet 42 containing storage devices for use with removable media, such as a floppy disk drive 44 and a CD-ROM drive 46. Computer cabinet 42 is detachable and is connected by a data cable 32 so that it can be located remotely if necessary to isolate its mechanical noise (fans, drive motors) from a recording studio. Input/output ports 26 may also be connected to an external data server, such as a network, which can provide large amounts of musical information, such as libraries of musical scores. In addition, the apparatus has a detachable data input keyboard 48 mounted on a support arm 52 with a quick-release clamp 50. Keyboard 48 facilitates rapid input of editing commands, text, and organizational data when the apparatus is being used as a stand-alone unit by an ensemble leader to prepare scores, and can be removed or swiveled out of the way when it is not needed, such as during rehearsals and performances. The functionality of keyboard 48 would also be provided by pointing device 14, but certain types of input are easier by keyboard.

FIG. 4 illustrates a possible configuration of apparatus as shown in FIG. 2 and FIG. 3 in a system for the display of musical scores and information to an ensemble under the direction of a leader, who can edit the scores and information. The apparatus unit 60 is provided for the ensemble leader, and is connected to at least one and preferably a plurality of apparatus units 62 and 64 provided for the musicians via data cables 66, for example. The ensemble leader's apparatus 60 is connected to the computer cabinet 72 via a data cable 70, and may also be connected to an external



data server, such as a network, via a data cable 74. The musicians' apparatus units 62 and 64 are interconnected via a plurality of data cables 68. The ensemble leader's unit 60 sends the score display information down data cables 66 and 68 and through each unit individually. Musicians' units 62 and 64 are differentiated by their software so that each one captures and displays only the appropriate score information. For example, units 62 might display the parts for brass instruments while units 64 display parts for woodwinds. A setup mode of leader's unit 70 allows the various musicians' units to be configured to receive and display the appropriate parts of the score.

Leader's unit 60 can also be connected via data cable 74 with auxiliary data processors. For example, when performing music that will be included on a motion picture sound track, various timing signals can be sent to leader's unit 60 to coordinate the timing of the music with the timing of the motion picture track.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

## WHAT IS CLAIMED IS:

1. Apparatus for displaying and annotating a musical score, comprising:
  - (i) a display screen;
  - (ii) a display controller for the controlling the display of the musical score on said display screen;
  - (iii) an input device for annotating the musical score on said display screen; and
  - (iv) at least one foot-operated controller for selecting a portion of the musical score to be displayed on said display screen.
2. The apparatus as in claim 1, further comprising:
  - (i) a base supporting the apparatus;
  - (ii) an extension from said base supporting said display screen; and
  - (iii) at least one mechanical adjustment point between said base and said display screen.
3. The apparatus as in claim 1, wherein said display controller features a data processor and at least one stored program.
4. The apparatus as in claim 1, wherein said display controller features a circuit of interconnected logic elements dedicated to the display and annotation of a musical score.
5. The apparatus as in claim 1, further comprising a data processor for editing the musical score.

6. The apparatus as in claim 1, further comprising a data input keyboard.
7. The apparatus as in claim 1, further comprising at least one data transfer device for exchanging data between the apparatus and at least one other device.
8. The apparatus as in claim 7, wherein said data transfer device features a removable media data storage device.
9. The apparatus as in claim 7, wherein said data transfer device features a data input/output device.
10. The apparatus as in claim 9, wherein said data input/output device features a data network access device.
11. A system comprising a plurality of apparatus for the simultaneous display of a musical score and annotations to a plurality of musicians, one of said apparatus serving as lead apparatus for distributing said musical score, and each of said apparatus comprising:
  - (i) a display screen;
  - (ii) a display controller for the controlling the display of the musical score on said display screen;
  - (iii) an input device for annotating the musical score on said display screen;
  - (iv) at least one data transfer device for exchanging data between said apparatus and at least one other device.

12. The system as in claim 11, wherein said data transfer device features a data input/output device.

13. The system as in claim 12, further comprising at least one apparatus as in claim 10.

14. The system as in claim 11, wherein said plurality of apparatus displays at least two different individual parts.

15. The system as in claim 14, wherein said apparatus is individually differentiated by the individual part to be displayed.

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58 60 10 66 64 5

52

Fl.  
Cl. in Sib.  
I  
Pag.  
II  
I in D  
Tr.  
II in C  
I  
Trp.  
II

50

54

Cl. in Sib.  
I  
Pag.  
II  
I in D  
Tr.  
II in C

50

56

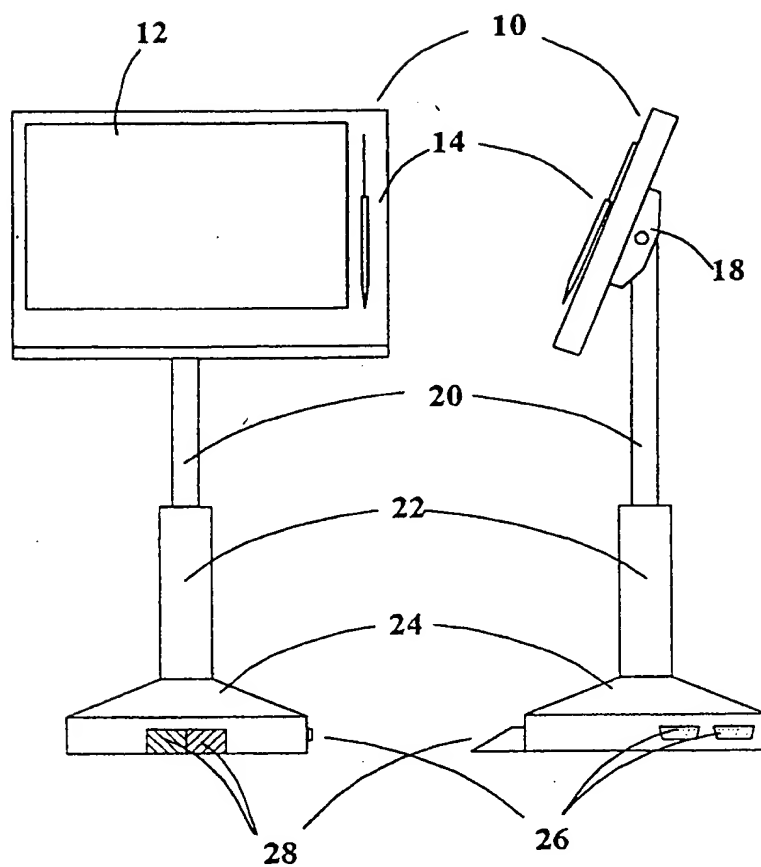
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FIG. 1. PRIOR ART

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3/4

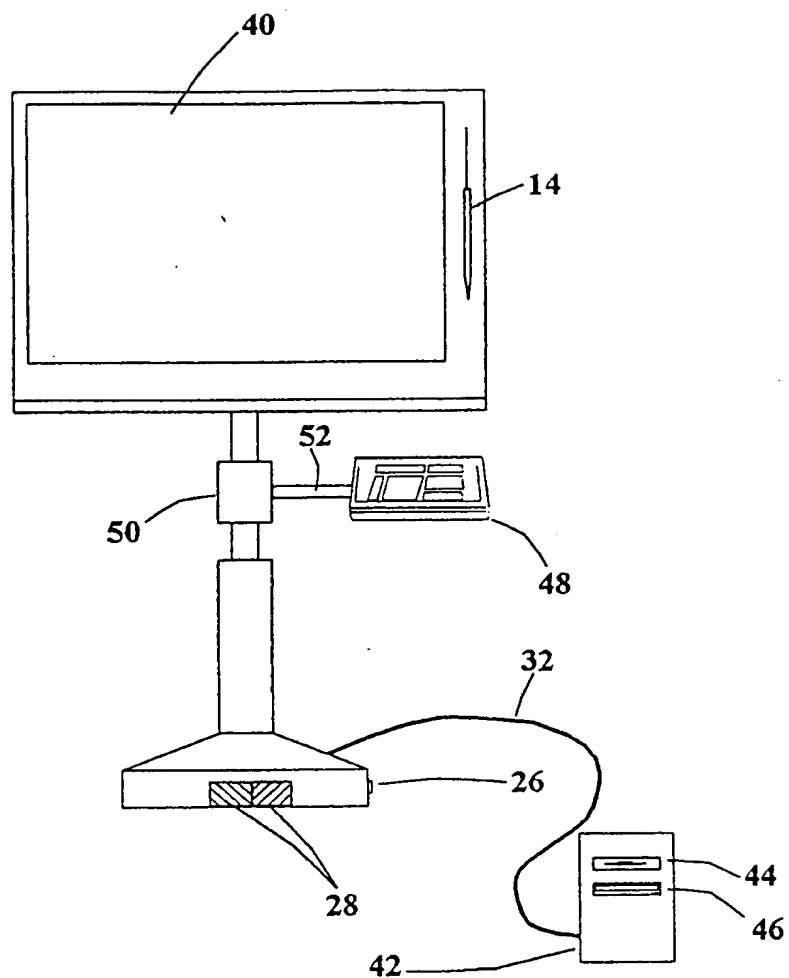


FIG. 3.

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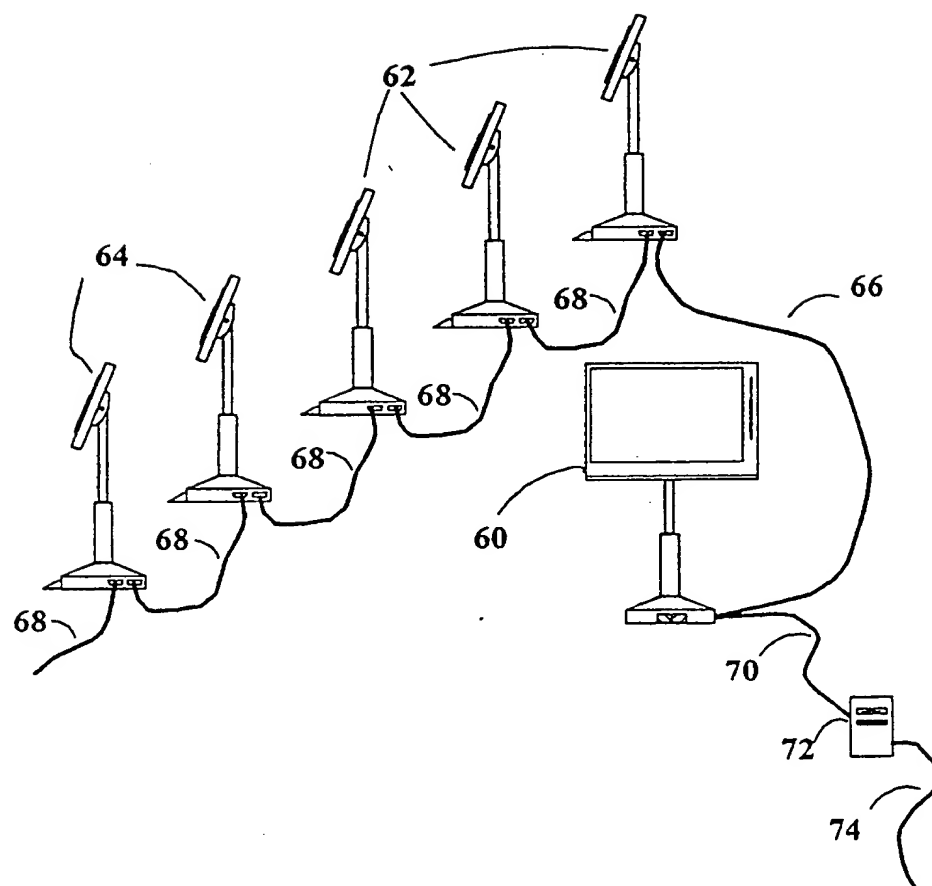


FIG. 4.



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/08658

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G09B 15/02

US CL :84/477R

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 84/477R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 5,400,687A (ISHII) 28 MARCH 1995 (28.03.95), ENTIRETY	1 ----- 2-10, 12-15
X,P ----- Y,P	US 5,728,960A (SITRICK) 17 MARCH 1998 (17.03.98), ENTIRETY	1 ----- 2-10, 12-15
Y	US 4,882,969A (RICCA) 28 NOVEMBER 1989 (28.11.89), ENTIRETY	2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
14 JULY 1998Date of mailing of the international search report  
30 JUL 1998Name and mailing address of the ISA/US  
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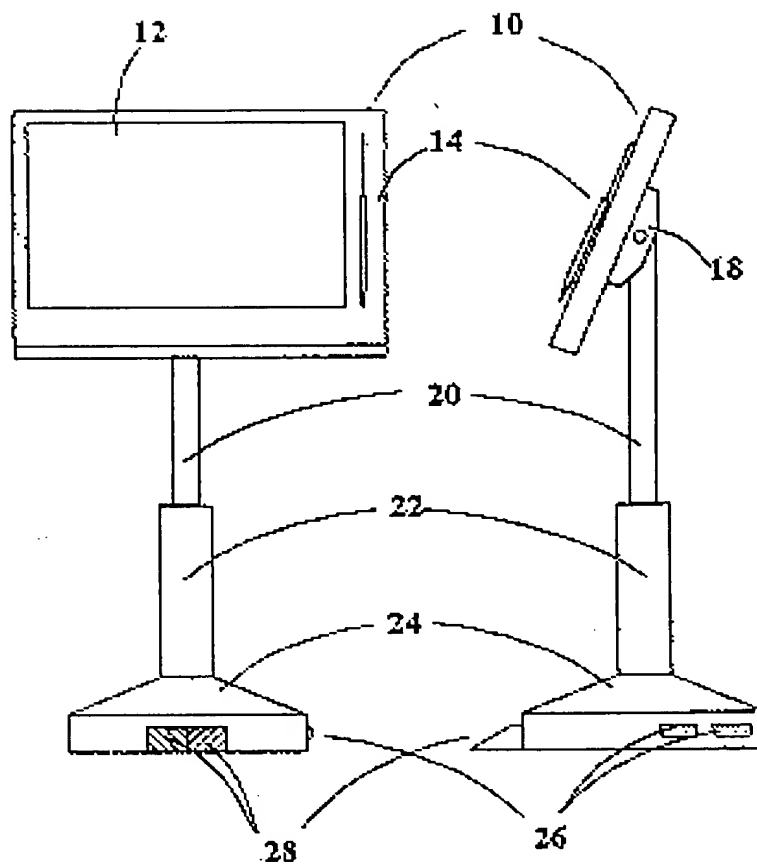


FIG. 2a.

FIG. 2b.

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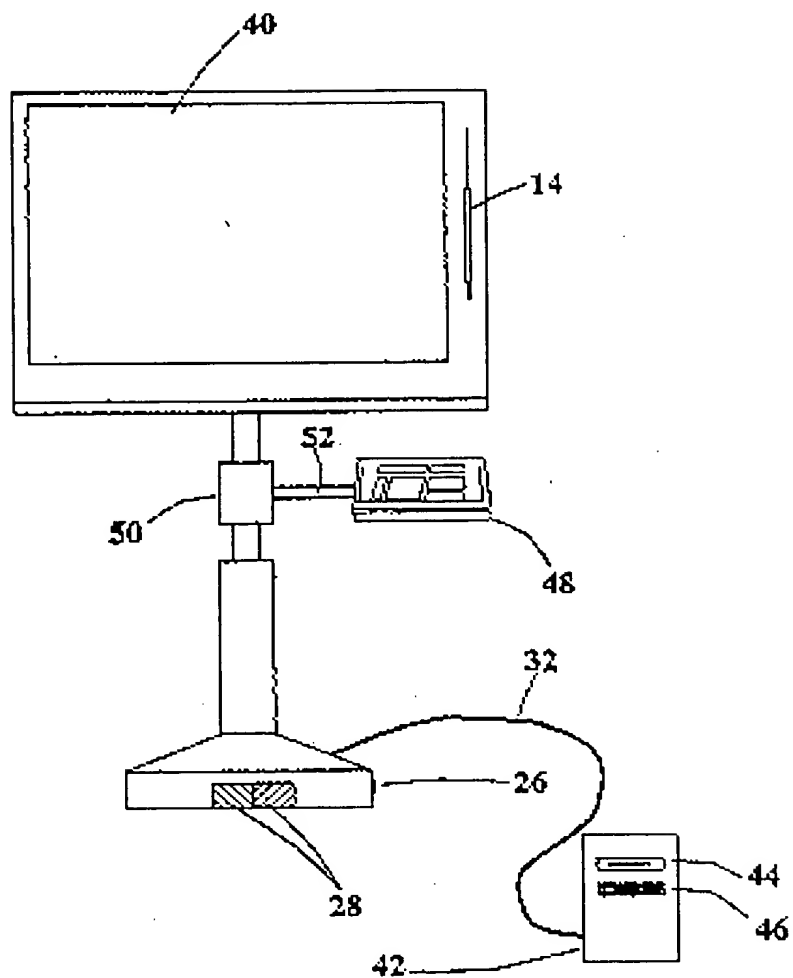


FIG. 3.

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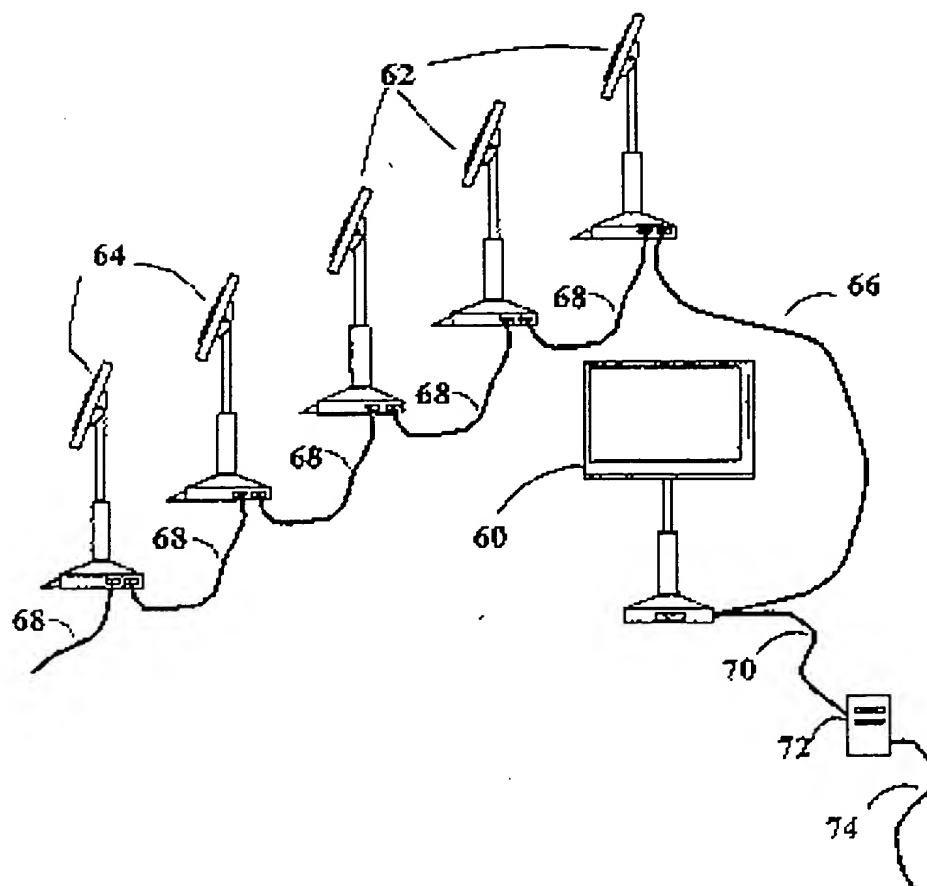


FIG. 4.